

Toward a Complete Phyloreferencing Language

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Standard Definitional Forms

Node-Based Clade

Dinosauria is the final common ancestor of *Iguanodon* and *Megalosaurus*, and all descendants thereof.

Branch-Based Clade

Ornithischia is the initial ancestor of *Iguanodon* which is not also ancestral to *Megalosaurus*, and all descendants thereof.

Apomorphy-Based Clade

Avialae is the initial ancestor of *Vultur* to possess wings used for powered flight synapomorphic with those in *Vultur*, and all descendants thereof.

Exotic Definitional Forms

Ancestor-Based Clade

Panbiota is the initial ancestor of *Homo sapiens*, and all descendants thereof.

Apomorphy-Qualified Node-Based Clade

Pinnipedia is the final common ancestor of *Phoca*, *Otaria*, and *Odobenus*, and all descendants thereof, provided that the ancestor possess *flippers* synapomorphic with those of *Phoca*, *Otaria*, and *Odobenus*.

Apomorphy/Branch Intersection-Based Clade

Ichthyornis is the initial ancestor of YPM-VP 1450 to possess [a list of 5 apomorphies] synapomorphic with those in YPM-VP 1450 and not also ancestral to *Struthio*, *Tinamus*, or *Vultur*, and all descendants thereof.

Modelling Phylogeny Mathematically

 **Taxonomic Unit**
Atomic Set

X

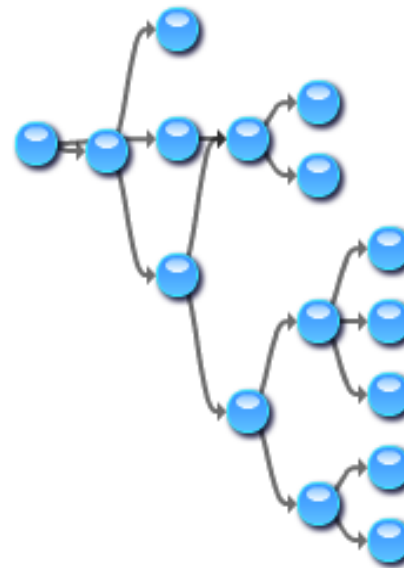
 **Immediate Descent**
Directed Edge

$[X_0, X_1]$



Higher Taxon
Set Union

$X_0 \cup X_1 \cup \dots X_n$



Phylogeny
Directed, Acyclic Graph

$[\{X_0, X_1, \dots X_n\}, \{[X_a, X_b], [X_c, X_d], \dots [X_y, X_z]\}]$

PREDEFINED ENTITIES

Taxonomic Units	<i>Set of Atomic Sets</i>
Immediate Descent	<i>Antisymmetric, Nontransitive Relation</i>

DERIVED ENTITIES

Phylogeny	<i>Directed, Acyclic Graph</i>
Universal Taxon	<i>Union of All Atomic Sets</i>
Descent Relation	<i>Transitive Closure of Immediate Descent</i>

PHYLOGENETIC FUNCTIONS

MAXIMAL	MINIMAL
PREDECESSORUNION	SUCCESSORUNION
PREDECESSORINTERSECT	SUCCESSORINTERSECT
LINEAGES	

CLADE ANCESTOR & CLADE FUNCTIONS

SYNAPOMORPHICPREDECESSORS
BRANCH CLADE
CROWNCLADE TOTALCLADE

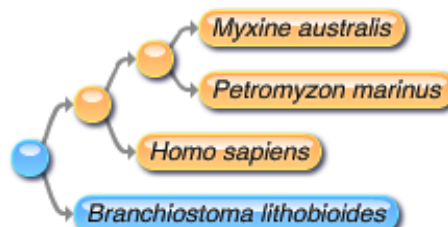
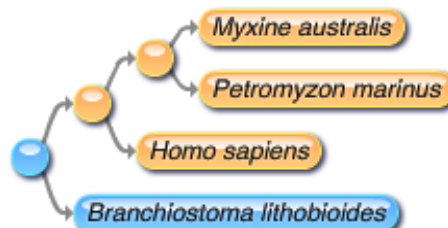
full definitions at <http://namesonnodes.org/>

Heterodefinitional Synonymy (Context-Dependent)

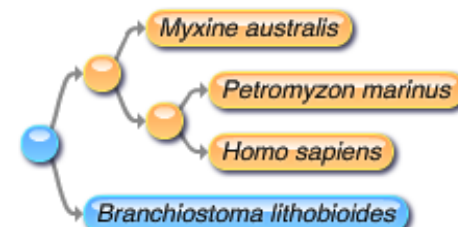
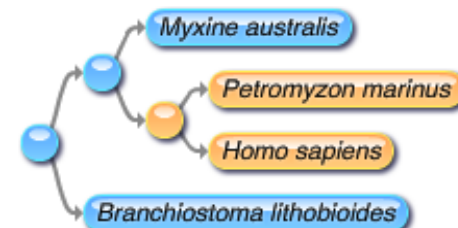
Vertebrata :=
CLADE(*Homo sapiens* u
Petromyzon marinus).

Craniata :=
CLADE(*Homo sapiens* u
Petromyzon marinus u
Myxine australis).

PHYLOGENETIC CONTEXT #1



PHYLOGENETIC CONTEXT #2



PHYLOREFERENCE #1

CLADE(*Homo sapiens* Linnaeus 1758
u *Lampetra marina* Malm 1863)

normalize

CANONICAL FORM

CLADE("urn:lsid:ubio.org:namebank:109086"
u "urn:lsid:ubio.org:namebank:135116")

normalize

PHYLOREFERENCE #2

(CLADE ◦ U)(*Homo sapiens* Linnaeus 1758,
Petromyzon marinus Linnaeus 1758)

Homodefinitional Synonymy (Universal)

Names on Nodes

web application using
MathML for phyloreferencing

<http://namesonnodes.org/>